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Internet of things in public healthcare organizations: the mediating role of attitude

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ABSTRACT

Internet of things (IoT) is a promising technology to face the challenges of COVID19 and enhance the capacities of public hospitals. However, few of the literature examined the behavioural intention (BI) of patients to use the IoT wearable health device (IoTWHD). This paper aims to examine the factor that affect the BI toward using the IoTWHD. The study proposes that variables of Technology acceptance model (TAM3) along with unified theory of acceptance and use of technology (UTAUT) can explain the BI. The population is the patients of public hospitals. Convivence sampling was deployed to collect the data using a questionnaire. 161 respondents participated in this study. The finding of Smart Partial Least Square showed that subjective norms (SN) affected the perceived usefulness (PU). Perceived enjoyment (PE) affected the perceived ease of use (PEOU). Further, PU, PEOU and perceived security (PS) affected the BI to use IoTWHD. Attitude mediated the effect of PU and PEOU on BI. More positive word of mouth are needed to enhance the perception of patients about BI to use IoTWHD in public health organizations.

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1. INTRODUCTION

The COVID-19 outbreak has not only destabilized businesses and economies but also public health organizations [1]. Hospitals and healthcare facilities around the world are struggling to cope with the increasing number of COVID-19 patients who require hospitalization and care to recover. Even with the emergence of new COVID-19 variants such as Delta and Omicron, public hospitals, particularly in developing countries, continue to face challenges in managing patient capacities [2]. To combat this, the use of technology is crucial. One promising technology that has been utilized in medical care is the internet of things (IoT) [3].

IoT, a groundbreaking innovation, enables machines to communicate with each other without any human interaction or intervention, using sensors to share user data with other devices [4]. Its applications have permeated all aspects of life, including business, health, and education. Over the past decade, the number of IoT-enabled devices has seen a massive surge and continues to trend upward. Experts predict that by 2025, there will be over 74 billion IoT devices in existence, with an average of nine devices per person on the planet [5]. The utilization of IoT technology presents a solution to the capacity challenges faced by public hospitals. Wearable healthcare devices powered by IoT can monitor patients' statuses and transmit real-time information to hospital doctors. This application is particularly beneficial for patients with chronic diseases who require

frequent medical check-ups. By using IoT-enabled wearable devices, such as watches or smartphones, patients can receive life-saving medical attention while minimizing overcrowding in public hospitals [6].

Although the usage of internet of things wearable health device (IoTWHD) is crucial, particularly during the time of COVID19 and its new generation, it is still limited and in the early stages of development [7]. Current literature mainly focuses on developed countries that have the required infrastructure and technical expertise to use this technology [8]–[10]. Furthermore, the literature primarily addresses the technical aspects of using IoTWHD, such as connectivity, sensors, networking, and programming. The acceptance and individual usage of this technology are still under investigation [11]–[13].

Previous research suggests that studies on the individual usage and acceptance of IoT technology are predominantly technical in nature and the behavioral aspect has not received sufficient attention [14]–[17]. Furthermore, scholars argue that the mechanism through which IoT can affect individual and social acceptance is not yet fully understood [18]. The user experience of IoT is still emerging, and further research is necessary to explore the factors that can encourage users to adopt IoT [19], [20].

The adoption of new technology is a complex process, and several behavioral theories have been developed to explain it. One of the widely used models is the technology acceptance model (TAM), which was first proposed by [21]. TAM suggests that the use of new technology is influenced by two key factors: perceived usefulness (PU) and perceived ease of use (PEOU). Attitude (ATT) acts as a mediating variable that affects the behavioral intention (BI), which in turn influences use behavior (UB). To build on this model, Venkatesh and Davis [22] developed TAM2, which emphasizes the fit between the individual's work and the technology's usage. The latest development of TAM is TAM3, which includes additional variables such as anxiety and adjustment [23]. In the context of COVID-19, anxiety is an important factor that can affect the adoption of new technology. However, the original TAM and its extensions have been criticized for neglecting security and privacy factors [24], which are crucial for using any technology, including the IoT [24]–[26].

The adoption of IoT and IoTWHD in particular has been scarcely studied in developing countries, including Iraq [27]. Due to the limited use of technology in Iraq and the ongoing efforts of the government to improve infrastructure, facilitating conditions are crucial for the sustained usage of IoTWHD. This study seeks to investigate the factors that influence the adoption of IoTWHD among patients in Iraq who require regular medical treatment and visits to hospitals. The subsequent section will provide a review of the relevant literature, followed by a description of the methodology, findings, discussion, and conclusion.

2. LITERATURE REVIEW

The subsequent section explores the available literature related to IoT in Iraq. It introduces the theoretical framework which include the TAM3 and the UTAUT. These theoretical frameworks support the creation of the conceptual framework in this manuscript. In addition, the section also disucsses the development of the hypotheses of this study.

2.1. IoT in Iraq

Technology adoption in general in Iraq is limited and this could be due to long period of instability and the trust in the technology. IoT is being used by a limited number of users. The technology is provided by telecommunication companies for the purpose of commercial use. In Iraq and everywhere, technology has assisted the policy makers in tracking the infected with COVID19 and isolating them and their surrounding by using the QR scan [28]. Existing studies in the country noted the lack of using IoT among people in Iraq and the lack of studies that can explain the behavior of users toward this technology [7]. For this reason, this study examines the issue in the context of Iraq.

2.2. Theoretical framework

This study deploys TAM3 which indicate that the usage of technology is affected by the work context, anxiety, and the adjustment which have impact on the PU and PEOU [23]. Computer or technology anxiety as well as enjoyment are critical in determining the PEOU while the subjective norms and relevance of the technology can determine the PU. Both PU and PEOU proposed by original TAM to affect the ATT which also proposed to affect the BI. TAM was criticized for lack of using technological factors. To account for criticism, security of the IoTWHD is considered as an important variable in this study. Moreover, the UTAUT, developed by [29], highlights the significance of facilitating conditions (FC) in the context of Iraq.

2.3. Conceptual framework and hypotheses development

The proposed framework considers the role of perceived security (PS) as an important factor affecting BI. PS is considered as an essential factor in the adoption of IoT as it affects users' trust and confidence in the technology. The study also hypothesizes that subjective norms (SN) will positively influence PU since users

are more likely to adopt IoTWHD if they perceive it as beneficial and socially acceptable. Additionally, the proposed framework posits that TA and PE will affect PEOU. Users with high levels of technology anxiety are expected to perceive IoTWHD as difficult to use, while users with high levels of perceived enjoyment are more likely to perceive it as easy to use. Finally, FC is expected to positively influence BI as it represents the external factors that may facilitate or inhibit the adoption of IoTWHD. Overall, the proposed framework provides a comprehensive and theoretically grounded approach to understanding the determinants of IoTWHD adoption in the context of Iraq. Figure 1 shows the proposed conceptual framework of this study.

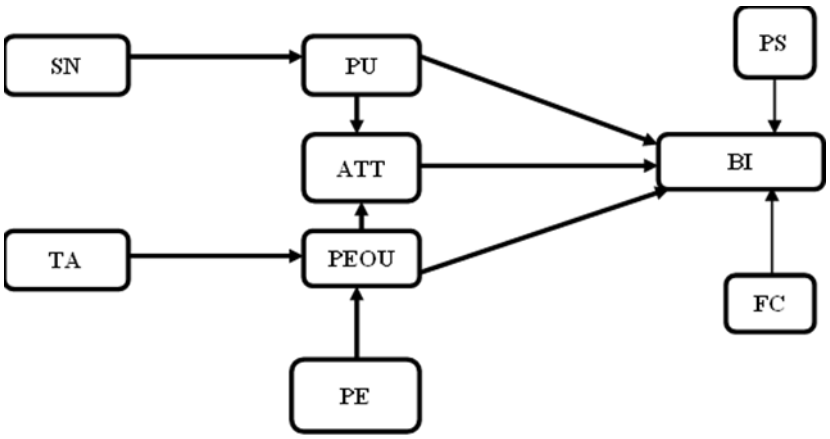

Figure 1. Proposed framework

2.3.1. SN and PU

According to [30], SN refers to the perception of significant others that influences individuals' decision-making. The Theory of Planned Behaviour (TPB) and Unified Theory of Acceptance and Use of Technology (UTAUT) have both suggested that SN is a crucial variable that can affect BI [29], [30]. Specifically, TAM3 proposes a direct relationship between SN and PU [23]. Previous studies have also investigated the association between SN and PU and found a positive correlation [31]–[33]. Based on these findings, it is suggested that:
H1: SN has a positive impact on PU.

2.3.2. TA and PEOU

The TAM3 model proposes that technology anxiety (TA) can impact the PEOU of a technology. Users who lack knowledge or experience with a technology tend to feel anxious about using it [34]. The effect of TA on PEOU is mixed in prior research. For example, one study [35] found that TA did not significantly affect PEOU, while others [36], [37] identified it as a critical determinant of PEOU. In the context of Iraq, where technology adoption is still limited, it is hypothesized that technology anxiety will have a significant impact on PEOU. Therefore, the following hypothesis is proposed:
H2: TA has a significant impact on PEOU.

2.3.3. PE and PEOU

Perceived enjoyment (PE) is a variable that determines the PEOU according to TAM3. Despite being less frequently studied, this variable is especially relevant in the context of COVID-19. Users who are interested in technology and eager to learn about IoT tend to enjoy using the technology [38], [39]. Previous studies have shown that PE has a significant impact on PEOU [38], [39]. Thus, this study proposes the following hypothesis:
H3: PE affects the PEOU.

2.3.4. PU and BI

The perception of an individual regarding the potential benefits of using a technology is referred to as PU [40]. PU is a critical factor in the technology acceptance model (TAM) and is linked to BI. Previous studies have found a positive correlation between PU and the usage of IoT, indicating that users tend to adopt IoT when they perceive it as beneficial [16], [41], [42]. Therefore, this study proposes that the BI of individuals towards using IoTWHD will be positively influenced by their PU.
H4: PU affects positively BI to use IoTWHD.

2.3.5. PEOU and BI

PEOU is a key construct of TAM, and it is proposed to have an impact on BI. Previous studies have explored the relationship between PEOU and BI in various contexts. For example, a study by [43] investigated the relationship between PEOU and BI in healthcare devices and found a positive association. Likewise, the study by [44] revealed a positive correlation between PEOU and BI in the use of IoT. In the context of IoTWHD, Mital *et al*. [16] demonstrated that PEOU has a positive impact on BI, and Karahoca *et al.* [41] arrived at a similar result in Turkey. However, some studies have reported no significant link between the two variables [45]. Therefore, the hypothesis is formulated as follows:
H5: PEOU affects BI to use IoTWHD.

2.3.6. Perceived security and BI

Perceived security (PS) refers to users' perception of IoT as being safe, secure, and trustworthy [46]. Many studies have emphasized the significance of PS in the usage of IoT. For example, Pinochet *et al*. [47] highlighted the importance of PS in IoT adoption and repurchase intention. Similarly, Chouk and Mani [48] found a positive association between perceived enjoyment and smart services. In this study, it is hypothesized that higher levels of PS will lead to increased adoption of IoTWHD by users.
H6: PS affects significant BI to use IoTWHD.

2.3.7. FC and BI

Favorable FC can increase an individual's intention to use IoT devices [49]. For instance, if a person has reliable and fast internet connectivity, access to devices that are compatible with IoT technology, and the requisite skills to use and integrate these devices into their daily lives, they are more likely to intend to use IoT technology [50]. Conversely, if an individual lacks access to necessary resources like compatible devices or reliable internet connectivity, their intention to use IoT technology may decrease. Furthermore, if an individual perceives the use of IoT technology as complicated or difficult, this can also negatively affect their intention to use it [43].
H7: FC affects the BI to use IoTWHD.

2.3.8. ATT as a mediator

TAM proposes ATT as a mediating variable, which has been studied in the context of IoT in a few instances. For instance, previous research by Choi and Kim [44] examined the impact of ATT on BI to use IoT, and found a positive correlation between the two variables. Additionally, Hsu and Lin [20] investigated the mediating role of ATT and discovered a partial mediation. Furthermore, Wang *et al*. [51] found that ATT mediated the impact of PU on BI to use IoT. Based on these findings, the following hypothesis is proposed:
H8: ATT mediates the effect of PU on BI.
H9: ATT mediates the effect of PEOU on BI.

3. RESEARCH METHODOLOGY

The present research is grounded on a positivist philosophy, utilizing a deductive approach. The research methodology adopts a survey strategy, and the data is collected through a cross-sectional time horizon. The study population is comprised of patients who seek medical attention at hospitals in Iraq. Convenience sampling was employed as there is no existing database of individuals with chronic illnesses in Iraq. A questionnaire serves as the primary research instrument, which was adapted from several previous studies. PU (4 items), ATT (4 items), and PEOU (3 items) were adopted from [41], PS (3 items) from [52], and FC (5 items) and BI (5 items) from [53]. SN (4 items), TA (4 items), and PE (4 items) were adopted from [23]. Experts fluent in both Arabic and English languages translated and validated the questionnaire. Prior to the data collection, a pilot study was conducted to assess the reliability of the measurements using Cronbach's Alpha (CA), and it was determined that all the measurements were reliable with CA greater than 0.70, as recommended by [54]. The management of five public hospitals was contacted to assist in distributing the questionnaire. In total, 391 questionnaires were distributed with reminders sent to collect additional responses, resulting in a total of 179 collected questionnaires. According to [55], responses between 100-150 are deemed sufficient for using smart partial least square (Smart PLS). The collected data were analyzed for missing values, outliers, normality, and multicollinearity. Seven responses had more than 15% missing responses and were subsequently deleted, while 11 responses were identified as outliers. This led to 161 complete responses. Normality and multicollinearity were also checked and found to be satisfactory. These analyses were conducted following the recommendations of [56], with the results presented in Table 1.

Table 1. Data screening (N=161)

Variable	Normality		Multicollinearity	
	Skewness	Kurtosis	Tolerance	VIF
ATT	-.39	-.37	.49	1.31
TA	-.32	-.41	.48	1.22
FC	-.43	-.49	.59	1.19
PEOU	-.79	-.49	.69	1.49
PS	-.49	-.59	.68	1.19
PE	-.78	-.49	.49	1.29
SN	-.69	-.39	.48	1.39
BI	-.59	-.38	-	-

4. FINDINGS

Descriptive information of respondents as well as the analysis of smart partial least square are discussed in this section. The section disucsses the profile of the respondents. In addition, the measurement model and the structural model are discussed in this section. The hypotheses testing of this study are examined in the following sub-sections.

4.1. Profile of respondents

The total of 161 respondents participated in this study. The respondents are majority males (73%) and 27% are females. The age group of the respondents is between 50-60 years (71%) and between 60 and above 21% while those less than 50 years are 8%. The education of the respondents are bachelor's degree 44%, high school 31% and less than high school is 25%. Majority of the respondents are self-employed 52%, 29% are working in public sector and 19% working for private sector.

4.2. Measurement model

To assess the measurement model (MM), the factor loading (FL), CA, composite reliability (CR), convergent validity using average variance extracted (AVE), and discriminant validity were assessed. FL for all items is larger than 0.70 except for SN2, PE1, and PS2. The CA and CR for all the variables is greater than 0.70 as shown in Table 2. In addition, the convergent validity is good since the AVE of the variables are greater than 0.50. For the discriminant validity, the root square of AVE is greater than the cross loading. This is acceptable based on [56].

Table 2. Outcome of assessing the reliabilities and validities

Variable	CA	CR	AVE	ATT	BI	FC	PEOU	PS	PU	PE	SN	TA
ATT	0.89	0.84	0.79	**0.91**								
BI	0.89	0.87	0.82	0.41	**0.90**							
FC	0.93	0.88	0.77	0.31	0.17	**0.88**						
PEOU	0.89	0.90	0.83	0.42	0.31	0.20	**0.92**					
PS	0.79	0.89	0.72	0.33	0.29	0.21	0.31	**0.84**				
PU	0.86	0.87	0.79	0.49	0.39	0.33	0.43	0.29	**0.90**			
PE	0.88	0.89	0.81	0.30	0.39	0.21	0.23	0.20	0.18	**0.89**		
SN	0.79	0.81	0.73	0.39	0.29	0.31	0.43	0.13	0.17	0.14	**0.87**	
TA	0.82	0.83	0.61	0.21	0.23	0.32	0.13	0.19	0.16	0.12	0.19	**0.72**

4.3. Structural model

The structural model in this study is evaluated against multiple criteria outlined in [56]. Analysis of the R-square revealed that 47.5% of BI could be explained by the variables. A Q-square greater than zero was observed, indicating that the independent variable has the ability to predict the dependent variable. With regards to the f-square, all paths except for FC→BI and TA→PEOU have values greater than 0.02. The structural model is presented in Figure 2.

Table 3 displays the path coefficient and the outcomes of the hypotheses testing for both direct and mediating effects. The outcomes of the hypotheses testing are presented in Table 3. The results indicate that H1 is supported, as SN has a positive effect on PU at B=0.58 and P<0.001. However, H2 is rejected since TA did not affect PEOU (P>0.05). H3 is supported, as the impact of PE on PEOU is significant at B=0.21 and P<0.001.

H4 is also supported, as the effect of PU on BI is significant. Similarly, H5 is supported as the impact of PEOU on BI is positive and significant. The effect of PS on BI is positive, hence H6 is supported. However, H7 is rejected as the effect of FC on BI is not significant. H8 is supported, as ATT mediates the effect of PU on BI through the indirect effect (PU→ATT→BI). The mediation is partial since both the direct and the indirect

effects are significant. Finally, H9 is supported as ATT partially mediates the effect of PEOU on BI through both the indirect and direct effects being significant.

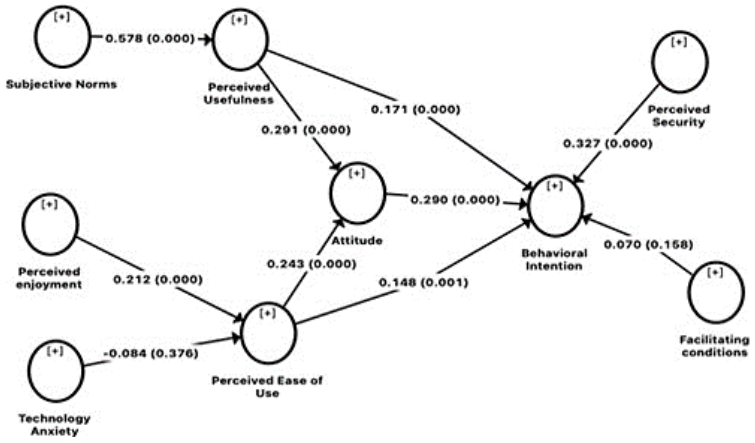

Figure 2. Structural model

Table 3. Result of hypotheses

H	Path	B	STD	T	P	Label
H1	SN -> PU	0.58	0.03	18.12	0.00	Supported
H2	TA -> PEOU	-0.08	0.10	0.89	0.38	Rejected
H3	PE -> PEOU	0.21	0.05	4.15	0.00	Supported
H4	PU -> BI	0.17	0.05	3.49	0.00	Supported
H5	PEOU -> BI	0.15	0.04	3.37	0.00	Supported
H6	PS -> BI	0.33	0.04	8.72	0.00	Supported
H7	FC -> BI	0.07	0.05	1.41	0.16	Rejected
H8	PU -> ATT -> BI	0.08	0.02	3.88	0.00	Supported
H9	PEOU -> ATT -> BI	0.07	0.02	3.48	0.00	Supported

5. DISCUSSION AND IMPLICATIONS

This study investigated the potential of IoTWHD in Iraq and its impact on patients in public hospitals. The study aimed to determine the effect of SN on PU and found a positive relationship between the two variables. This implies that if positive word-of-mouth about IoTWHD spreads among users through SN, their perception of PU will increase. Meanwhile, the study hypothesized that TA would negatively affect PEOU but found no evidence of this relationship. These findings are consistent with previous research that found a positive effect of SN on PU [31]-[33], as well as with research that investigated the impact of TA [35] and perceived enjoyment (PE) [38], [39] on PEOU.

The positive relationship between PE and PEOU indicates that incorporating fun and enjoyment in the use of IoTWHD can enhance the ease-of-use perception. Additionally, the study found that PU and PEOU are positively associated with BI, which suggests that the usefulness and ease of use of the technology are important for patients and can increase their willingness to use it. These findings are consistent with previous research [16], [41], [42]. Furthermore, the study found that PS has a positive impact on BI, indicating that patients are more likely to adopt IoTWHD when they perceive the technology as secure. Conversely, FC did not have a significant effect on BI, possibly because IoTWHD are similar to watches and do not require significant infrastructure beyond fast internet. These findings align with those of [47] for PS and [49] for FC. The study also confirmed the mediating role of ATT between PU, PEOU, and BI, indicating that ATT partially explains the effect of PU and PEOU on BI. This finding is consistent with the research conducted by Hsu and Lin [20].

This paper has made a significant contribution to the literature on the usage of IoT technology in public health organizations in developing countries. Unlike previous studies that primarily focused on the technical aspects of IoT, this study examined the behavioral approach and identified the factors that influence patients to use IoTWHD. By using a combination of TAM3 and UTAUT frameworks, the study was able to explain nearly half of the variation in BI, which is a significant achievement. In addition, the study also deployed mediating variables such as ATT to further explain the BI. This approach helped to provide a more comprehensive understanding of the relationships between the various constructs in the model and how they

influence patients' intention to use IoTWHD. The findings of the study highlight the importance of considering not only the technical aspects of IoT but also the behavioral factors that affect patients' adoption and usage of this technology.

This study is particularly significant for public health organizations in developing countries that face resource constraints and high pressure on their healthcare systems. By identifying the factors that influence patients to use IoTWHD, healthcare providers can devise strategies to enhance the adoption and usage of this technology, leading to improved health outcomes for patients. The study's findings provide valuable insights into the usage of IoT in public health organizations and open up opportunities for further research in this area. These findings are particularly relevant for decision-makers in public healthcare organizations in Iraq and other countries with similar characteristics. The study highlights the importance of SN, which needs to be improved to enhance the BI toward the usage of IoTWHD. Spreading positive word-of-mouth through TV series, social media advertisements, and educational institutions will encourage people to use IoTWHD and understand its benefits. Moreover, PE is another critical factor that should not be overlooked. Adding gamification elements to IoTWHD applications can make the experience more enjoyable for patients, especially during the COVID-19 pandemic. The study also emphasizes the importance of PU and PEOU, as they have been found to be critical for BI. Therefore, IoTWHD applications should be easy and straightforward to use, and their usage should be beneficial for patients. Ensuring the security of these applications is also important. By highlighting the benefits of using IoTWHD and spreading positive word-of-mouth, healthcare providers can help patients develop a positive attitude toward this technology.

6. CONCLUSION

The main objective of this study was to investigate the factors that could lead to an enhancement in the BI toward IoTWHD. The research data were obtained from patients who received treatment in public hospitals in Iraq. The study found that SN had an impact on PU, while PE affected PEOU. The study also revealed that PU, PEOU, and PS had a positive influence on BI toward IoTWHD, while FC did not. Moreover, ATT played a mediating role in the relationship between PU/PEOU and BI. The present findings are limited to the participants who took part in this study in Iraqi public hospitals and the usage of IoTWHD. To expand upon the results of this study, future research could be conducted using a random sampling technique. The findings could also be extended by examining patients in private hospitals, which may have better or worse equipment compared to public hospitals. Furthermore, future research should incorporate other variables such as the reliability of IoTWHD and the availability of these applications. The study's conclusions could be valuable for decision-makers in public health organizations looking to enhance the usage of IoTWHD.

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